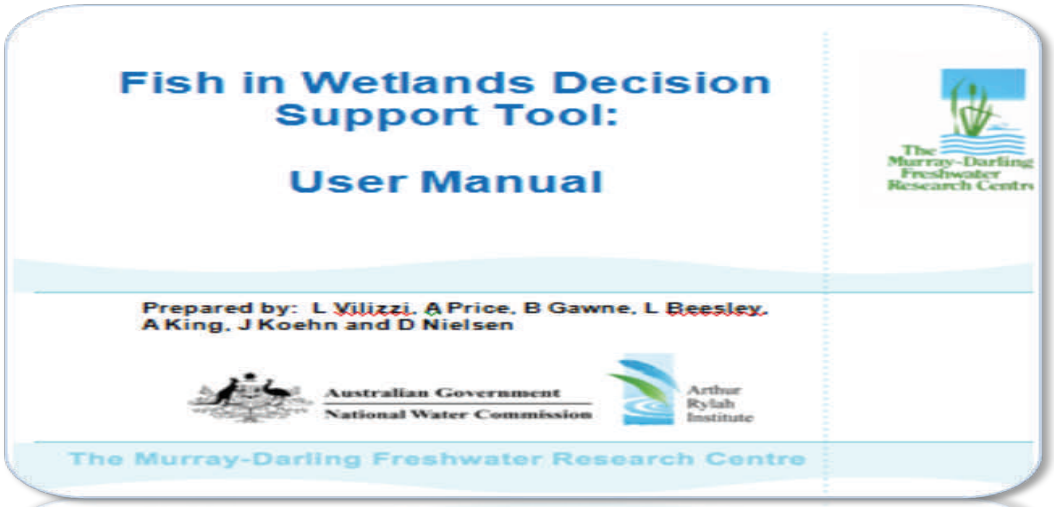
Australian Government
National Water Commission

Quick-guide User Manual
Fish-in-Wetlands
Decision Support Tool

This document is a condensed user manual that supports the *Fish-in-Wetlands Decision Support Tool (FWDST)*. It should be utilised as a quick reference guide on the functionality and content FWDST, but is not intended to replace the depth and breadth of information that is provided in the unabridged online version. Users are referred to www.mdfrc.org.au to access the FWDST and full user manual.


Fish in Wetlands Decision Support Tool:
User Manual
The Murray-Darling Freshwater Research Centre
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Australian Government
National Water Commission
Arthur Rylah Institute
The Murray-Darling Freshwater Research Centre

Purpose of the FWDST

The National Water Commission's *Optimising Environmental Watering Protocols to Benefit Native Fish Populations* project, aimed to provide critical information to water managers on how to make best use of environmental water to sustain native fish populations.

Wetlands are important for fish, but are typically watered for other biotic components, such as birds and vegetation. In the limited instances where fish are a management objective, watering is often undertaken to maintain wetlands as refuges, based on limited knowledge of fish habitat requirements. Beyond refuge maintenance, managers have limited information on how to water wetlands for positive fish outcomes. The scarcity of information on the response of native fish to inundation events prevents water managers from setting applicable management objectives. As part of the project, a predictive decision-support too - the Fish in wetlands Decision Support Tool (FWDST) that would enable managers to make informed decisions regarding timing, duration and depth of inundation and method of water delivery to maximise benefits to native fish communities in river-floodplain ecosystems, was developed. It is anticipated that predictions of fish responses would help inform both the prioritisation of wetland watering actions and decisions about the timing, magnitude and delivery of water to wetlands.

Description of the FWDST

The FWDST consists of four species-specific Bayesian network models, namely:

CARP – A Common carp (*Cyprinus carpio*) model

GOLDEN PERCH – A golden perch (*Macquaria ambigua*) model

GUDGEON – A carp gudgeon (*Hypseleotris* spp.) model

SMELT – An Australian smelt (*Retropinna semoni*) model.

These species were selected as they represent a diversity of life-history strategies and because sufficient ecological knowledge exists on which to base the Bayesian network. Each species-specific Bayesian network was constructed and populated based on expert opinion and validated using wetland response data.

The FWDST is designed to inform watering decisions for individual wetlands and can be confidently applied to wetlands in the Murray Valley. The FWDST is an annual model and aims to predict the fish population in the April following a single watering event and considers each individual watering event as discrete and independent.

This project was funded by the National Water Commission under the Raising National Water Standards program. It was undertaken by the Murray-Darling Freshwater Research Centre (MDFRC) in partnership with the Arthur Rylah Institute for Environmental Research (ARI).

Model structure including choice of levers, ecological process based and choice of outputs

The FWDST was based on a relatively simple conceptualisation of the relationships between wetland character, flow and fish responses. The Bayesian network includes two groups of input nodes (Figures 1 and 2). The first group comprises attributes of the wetland that were felt to influence the fish response to inundation. These nodes were important because they differentiate among wetlands and thus enabled the Bayesian network to support inter-wetland prioritisation decisions.

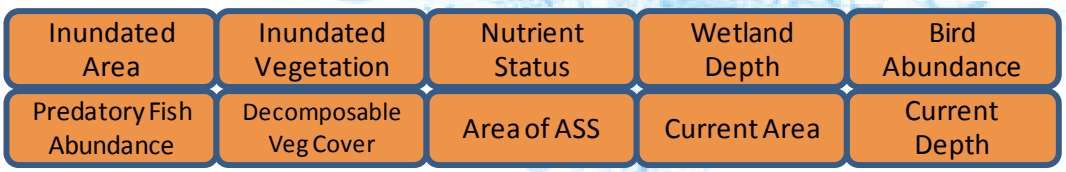

Figure 1: Wetland attribute input nodes used in the FWDST

The second group of input nodes describes the characteristics of watering events that managers have some control over (management levers). These nodes were developed from a manager survey, a follow-up workshop and targeted discussions with managers.

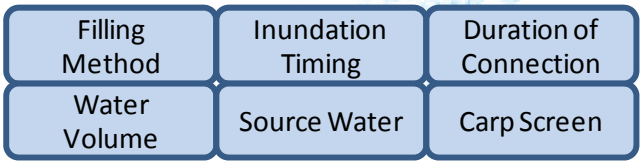

Figure 2: Watering attribute input nodes used in the FWDST

The DST provides outputs for 'fish abundance', 'fish condition', and 'population structure', as well as a summary of these three features 'population health' (Figure 3). The output that is most relevant will depend upon the aim of watering. Where a generic improvement in the health of the population is required information from the population health output node may be all that is relevant. If an increase or minimisation (e.g. pest species) of abundance is of interest, then abundance is the appropriate output.

The intermediate nodes and relationships in the Bayesian network describe the major influences on the three key population health characteristics (Figure 3). For abundance, these were additions to the population via immigration and breeding/recruitment and loss from the population via emigration and mortality through poor water quality and predation. The relative abundances of the different life-stages formed the basis of the population structure node. For fish condition, the major drivers were food availability and water quality. A relatively complex Bayesian network emerged from this rather simple conceptualisation, which the project team thought appropriate as it reflected the way we believed wetland systems operate and the key variables that fish respond to.

The complexity of the DST may make it appear daunting for managers. However, in recognition of the possibility that DST complexity will reduce adoption, advice was sought from managers and to address this, the FWDST is available in two forms: the full, complex BN (Figure 3); and a second simplified version in which the intermediate nodes are hidden so that managers only see the input and output nodes (Figure 4). The main advantage of the simplified interface is an uncluttered workspace. Conversely, the full interface allows managers to view all nodes in the model. Advantages to using the full interface include that managers can see how variation in management drivers are predicted to affect fish life stages either directly (e.g. Abundance nodes, Movement node) or indirectly (e.g. water quality risks, food abundance, predation risks). This process informs managers of the predicted relationship between management levers and the fish community, and also provides an opportunity for managers to decide if the intermediate outcome predicted by the model is appropriate for their case scenario.

Interpretation of model outputs

Interpreting model outputs requires an understanding of the relative nature of the outputs from the model and the uncertainty intrinsic within the model. All model outputs exist within a universal space – i.e. a hypothetical landscape covering small to massive wetlands, all potential variance in habitat, and factors not addressed in the model such as variance in watering regime, and geographic location. Because of this, 'good' or 'excellent' outputs may not be achievable within the sphere within which a manager is working. For example, if a manager is working with a small wetland, he or she may be able to adjust input nodes in the model to increase fish health from 'very poor' to 'poor', but maybe no more. This is because, all other things being equal, the abundance of fish in a very small wetland will always be lower than in an extremely large wetland and hence, relative to a large wetland fish health will be considered 'poor'. However, within a small wetland, or among small wetlands, an increase from 'very poor' to 'poor' may represent a biologically significant improvement.

Model outputs may also be lower than expected by management because of model complexity. Uncertainty is associated with all individual relationships within the model, and becomes compounded as relationships feed into one another as the model progresses towards the outputs (i.e. abundance, health etc). For example, even under 'ideal' circumstances, the model never predicts the fish response to be 100% excellent. The issues raised above stress that caution must be taken when interpreting model outputs. The direct use of model outputs is not recommended as it may be misleading or uninformative, rather it is strongly recommended that outputs are examined in relation to one another, i.e. the comparison of different scenarios. Thus, an add-on module to the FWDST has been developed to facilitate scenario comparisons, providing a measure of improvement (expressed as a percentage) from one scenario to the other.

Accessing the FWDST models

The FWDST, percent improvement tool and the associated user manual are freely available for download at www.mdfrc.org.au. The website also contains several PowerPoint/video examples to demonstrate the use of the model to either prioritise watering among wetlands or optimising outcomes from watering a specific wetland. A more complete description of the model development is described in the Waterlines Report, Watering floodplain wetlands in the Murray-Darling Basin for native fish (L Beesley, A Price, A King, B Gawne, D Nielsen, J Koehn, S Meredith, L Vilizzi, N Ning, S Hladyz) which is available from the Commissions' website www.nwc.gov.au.

The models are run using Netica (www.norsys.com) which is a Bayesian Network (BN) development software that can build, learn, modify, transform and store BNs. After installing Netica application, the four complete models ('CARP Full.neta', 'GOLDEN PERCH Full.neta', 'GUDGEON Full.neta', 'SMELT Full.neta') and the four simplified models ('CARP Simplified.neta', 'GOLDEN PERCH Simplified.neta', 'GUDGEON Simplified.neta', 'SMELT Simplified.neta') can be loaded either from the Windows Explorer shell by double-clicking on the file of choice or from within Netica.

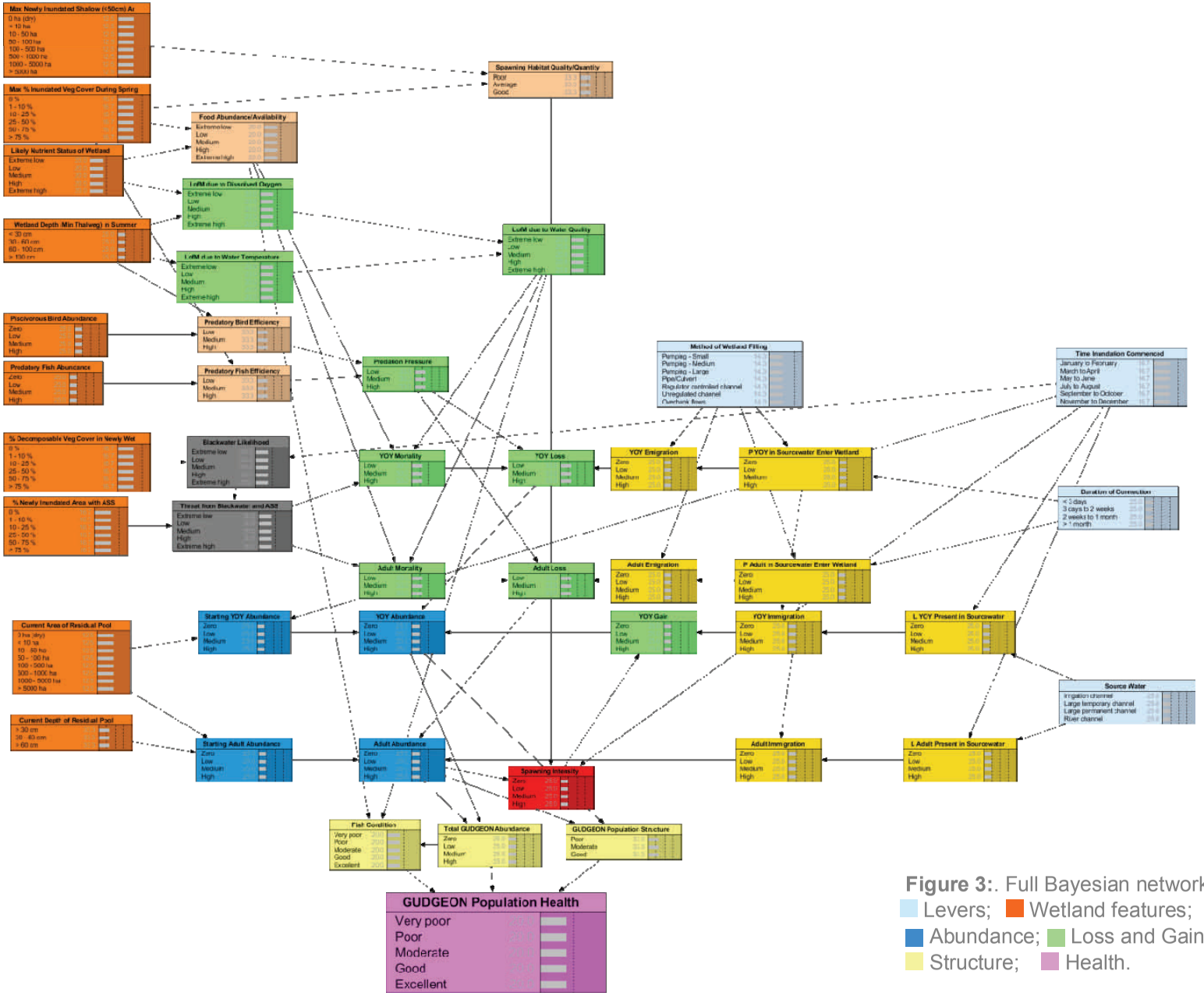

Figure 3:. Full Bayesian network for the GUDGEON model. Levers; Wetland features; Threats; Wetland derived; Abundance; Loss and Gain; Spawning ; Movement; Structure; Health.

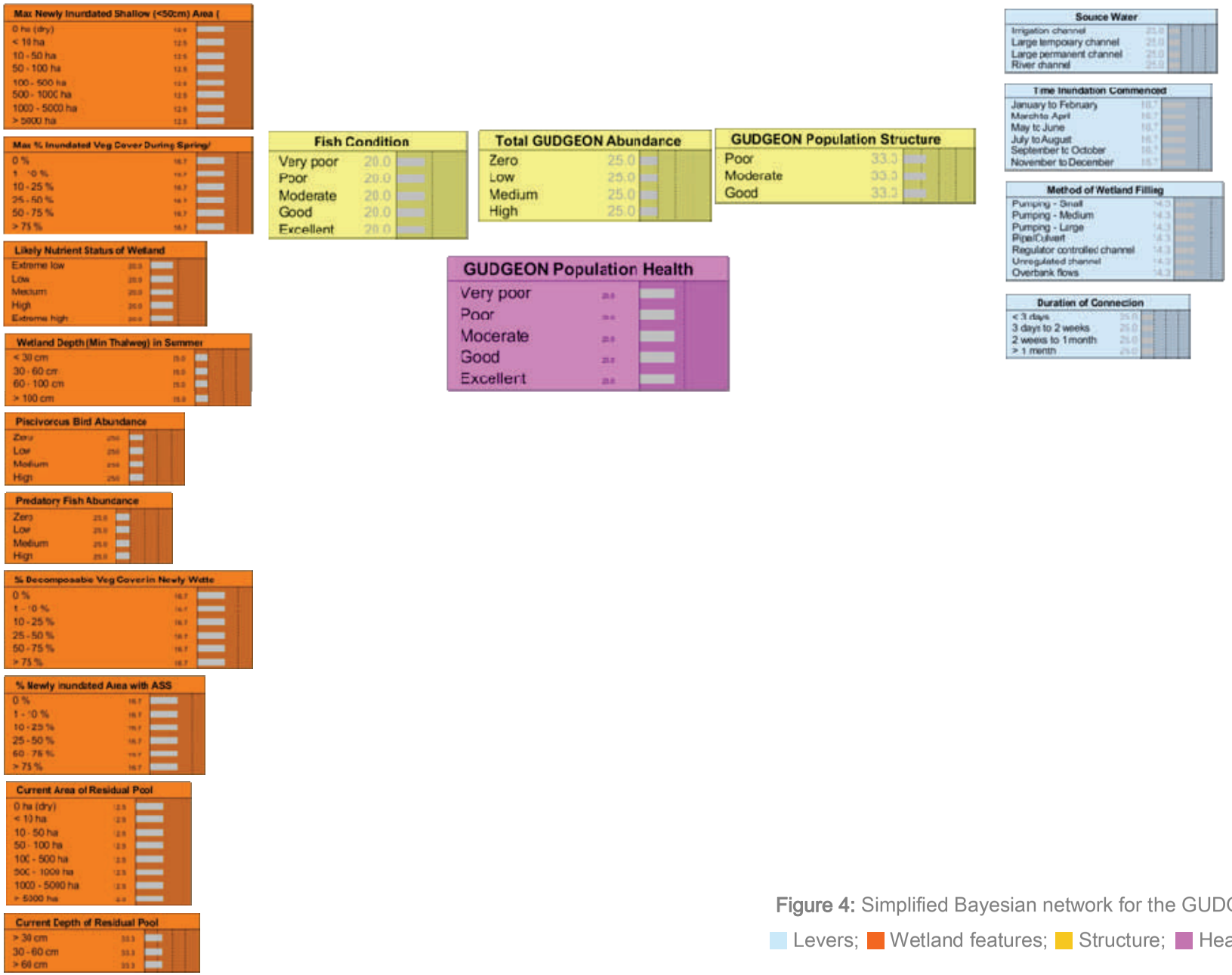

Figure 4: Simplified Bayesian network for the GUDGEON model.

Levers; Wetland features; Structure; Health.

Example 1: Which wetland to water?

DST scenario

You are managing the ecological values of several small wetlands. You have 150 ML of environmental water which you will deliver via a regulator (no carp screen) from the river. You estimate it will take 13 days for the water delivery. You were ready to water in spring but the permit was not approved until summer. You have two wetlands to choose between:

- Wetland A is an oxbow (billabong) with an area of approximately 20 ha prior to watering and a depth >60 cm. The wetland has no known history of acid sulphate soils (ASS), approximately 10–25% vegetation cover when inundated, and has not much decomposable vegetation. When it is watered your hydrological modelling (or best guess) tells you that a further 9 ha should be inundated. Once inundated, the depth in summer is likely to be greater than 1 m.
- Wetland B is a deflation basin and is currently dry. It has no known history of ASS, approximately 25-50% vegetation cover when inundated and is covered in leaves and weeds, so has a large amount of decomposable vegetation (>75%). When it is watered your hydrological modelling tells you that 25 ha should be inundated and maximum depth in summer should be 30–60 cm.

Neither wetland is likely to be colonised by a large number of piscivorous birds because there has been a large flood in central Australia and they have all taken off. You have no idea about the likely nutrient status of the wetland or predatory fish abundances, but you predict that vegetation cover in the wetlands is 10–25%. The DST is run to assess the population health response for native fish and for carp in wetland A compared to wetland B.

DST prediction

The DST predicts that the population health of all species (native and alien) will be better in wetland A than in wetland B (Table 1). The DST predicts that in wetland A there is a greater than 80% chance that population health will be poor to moderate for all species except Golden Perch (49% probability of a poor response and 41% chance of a very poor response). In wetland B, however, there is a greater than 95% chance that the population health will be very poor to poor for all species. Whilst the models indicate that a better response is likely in wetland A for all species, the output for wetland A does not appear ideal and is limited by the small size of the wetland. In this instance running the model comparison module may be more appropriate than reporting the outputs from the models directly. Results from the model comparison module show that the response of Carp is predicted to be 59.3% better in wetland A, the response of Golden Perch is predicted to be 27.5% better in wetland A, the response of Carp Gudgeons is predicted to be 66.6% better in wetland A and the response of Australian Smelt is predicted to be 80.7% better in wetland A.

Table 1: DST outputs for *Example 1: which wetland to water*? Note that probability values change marginally each time the DST is run. A and B refer to the wetlands.

	CARP		GOLDEN PERCH		GUDGEON		SMELT	
Population Health	*A*	*B*	*A*	*B*	*A*	*B*	*A*	*B*
Very poor	6.0	50.7	41.5	69.8	17.4	75.7	11.2	76.9
Poor	40.9	40.0	49.5	28.8	56.6	22.6	55.8	21.9
Moderate	46.9	9.0	8.6	1.4	24.7	1.7	30.4	1.2
Good	6.0	0.4	0.4	0.5	1.3	0.1	2.6	0.0
Excellent	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0

Example 2: Improving the native fish response through changes to method and timing of delivery

DST scenario

You are managing a large wetland in the lower Murray. You have been watering at the end of the irrigation season (May) because that is when the water has become available. The high river bank means that you usually pump water into your wetlands. Pumping water in May is fine for watering lignum, but you suspect that few fish make it alive through the pump. You are wondering if it would be worthwhile to construct a regulated channel and to water during the fish breeding season.

Prior to watering, the wetland is 150 ha in size and 30–60 cm deep. You have 1 GL of water which will take over a month to deliver and will inundate a further 110 ha. After watering, the wetland is likely to be 60–100 cm deep and have high levels (50–75%) of inundated vegetation. The wetland has 10–25% decomposable vegetation and wetlands in the area are at low risk from acid sulphate soils. You don't have any idea about predatory fish abundance, but piscivorous bird abundances are likely to be medium. You don't have any idea about the wetland's nutrient status.

The DST is run to evaluate watering using a medium pump in May and then to evaluate watering in November using a regulator.

DST prediction

The DST predicts that for this wetland, watering in May using a medium pump will result in a 85% probability of a very poor response for Golden Perch, a 63% probability of a poor response for Australian Smelt and a 57% probability of a poor response for Carp Gudgeon (Table 2). The DST predicts that watering in November through a regulator will result in improved outcomes for all three native species (Table 2). The DST predicts that the chance of a very poor response for Golden perch is reduced to 30% and the chance of a poor and moderate response increased to 52% and 17% respectively. For Australian Smelt, the chance of a poor response decreases to 44% and there is now a 46% probability of a moderate response. The probability of a poor response for Carp Gudgeon decreases to 38% and a moderate response is most likely (probability of 50%). In terms of overall percent improvement, the response of Golden Perch is predicted to be 39.3% better if the wetland is watered via a regulator in November, the response of Australian Smelt is predicted to be 18.4% better and the response of Carp Gudgeon is predicted to be 15% better.

Table 2: DST outputs for *Example 2: improving native fish response through changes to method and timing of delivery*. Note that probability values change marginally each time the DST is run. A = medium pump in May; B = regulator in November.

	GOLDEN PERCH		GUDGEON		SMELT	
Population Health	*A*	*B*	*A*	*B*	*A*	*B*
Very poor	85.5	29.6	9.9	2.6	14.9	3.6
Poor	13.7	52.1	56.7	38.3	62.5	43.7
Moderate	0.7	16.9	30.4	49.6	21.2	45.7
Good	0.3	1.4	3.0	9.1	1.4	6.7
Excellent	0.0	0.0	0	0.4	0.0	0.2

For more information visit
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